Arrangement and method for locating data carriers.

a> Background of the Invention

The invention relates to an arrangement for and method of locating objects provided with data carriers.

Such methods enable persons or devices to be located in respective areas. For this purpose, the objects have a portable data carrier which receives position data from a positioning system, for example the Global Positioning System (GPS).

US 5,490,079 describes a system for automated toll collection which utilizes GPS. The system operates with a tag which includes a GPS sensor. When the tag determines that it is situated in such an area, it sends a signal to a receiver. The time of staying in the toll area is stored in the tag. When the toll fee which is due has been paid at an authorized point of payment the amount of toll incurred is cleared. In the case of non-payment of this toll the tag is deactivated after a given time. The tag inter alia includes a memory which stores the toll areas.

a > SUMMARY OF THE INVENTION

In order to enable a universal use of such a data carrier the size of the data carrier should be small in relation to the object. On the other hand, such mobile data carriers require batteries which must be small but should have a long life.

Often, the absolute position of an object or person is not relevant and for many uses it is sufficient when more general area information or the relative position is available.

It is an object of the invention to provide an arrangement and a method by which the exchange of data between data carrier and information unit.

This object is achieved by means of the arrangement defined in Claim 1 and by means of the method defined in Claim 3.

The locating system essentially consists of three components: a position-determining system, an object provided with a data carrier and an information unit.

Upon its initialization the data carrier transmits its absolute coordinates, which represent its absolute position, to the information unit. The information unit stores corresponding areas in electronic maps. The information unit translates the respective absolute coordinates of the data carrier into the relative area data. Moreover, the data of the area in which the data carrier is currently located is stored. The information unit transmits the

boundaries of the area in which the object is located back to the data carrier, where this data is then stored.

Since the object can move within its area, in other areas and also outside the area defined by area boundaries, the data carrier requests its absolute position in definable distances from the position-determining system. By a comparison of this absolute position with the boundaries stored for the area it is determined whether the data carrier is still within the respective stored area. As long as this comparison reveals that the object with the data carrier is still located in the respective area there is no communication between the data carrier and the information unit. Once the data carrier detects that its absolute coordinates lie outside the area stored in the carrier it will transmit its new position to the information unit.

An advantage of this method is that the relative position of the object is continually available in the information unit for any application for which the location of the object is of interest.

This reduces the communication between the data carrier and the information unit to a minimum.

Since the information unit stores, for example, toll areas or application-specific areas the data carrier need not be as intricate and expensive. The stored areas can be changed any time without modification of the data carrier.

How many time the data carrier requests its absolute position from the positioning apparatus depends particularly on the required accuracy but also on the speed with which the object travels.

Applications, for example locating systems which are interested in the location of the object but for which the absolute position is not crucial can at any time query the information unit for the instantaneous area where the data carrier is located via existing infrastructural networks.

Situations may arise in which the data carrier is briefly out of contact with the information unit, for example when infrared or radio networks with incomplete coverage are used. The failing contact between the information unit and the object with the data carrier is then not a problem because the information unit stores the area or, in general terms, the relative position of the object.

The relevant application need not immediately interrogate the individual data carriers for each query. This simplifies the communication means. In addition, a plurality of applications can be provided with area information of the objects without each individual application having to communicate with the objects.

As a result of this reduction of the communication means the batteries and, consequently, the logic means necessary in the data carrier can be small. On the one hand, this extends the operating period of such a data carrier and, on the other hand, it extends its fields of use.

a > Brief description of the drawings

Further advantageous embodiments of the invention will be apparent from the description and the accompanying drawings. In the drawings:

Figure 1 shows a block diagram of an arrangement in accordance with the invention,

Figure 2 shows the structure of a data carrier in conjunction with the position-determining system and the information unit, and

Figure 3 shows a time chart for the components involved.

a > Detailed description of the preferred embodiments

Figure 1 shows the structure of an arrangement in accordance with the invention. The information unit 5 monitors for example four areas 1, 2, 3 and 4 in which objects to be monitored and each having a respective data carrier 11, 12, 13 or 14 is located. The position-determining system 6 transmits the absolute position data to the data carriers 11 to 14. Said absolution position data is transmitted to the information unit 5 in dependence on the mode of the data carrier. In turn-on mode of the data carrier the absolute position data is transmitted directly to the information unit. The information unit 5 transmits boundaries of the respective area in which the data carriers 11-14 are currently located back to said carriers. Apart from this, the absolute position data is only transmitted to the information unit 5 when these lie outside the stored limits of the current instantaneous area. Applications 7 for which the location of the data carriers 11 to 14 is of interest receive the current area information from a data bank from the information unit 5. For this purpose the data carrier need not be contacted. If applications need to respond under given conditions the information unit 5 transmits a message to the application when the respective condition occurs.

Figure 2 shows the data carrier 11, which includes a position sensor 20, a transmitter 21, a receiver 22, a memory 23 and a comparator 24. By means of the position sensor 20 the data carrier 11 receives its absolute position data, for example its absolute coordinates in a space or the geographical position with a length and width specification, from the position-determining system 6. For the position-determining system 6 the Global Positioning System (GPS) can be used. It is likewise possible to use local position-determining systems operating with infrared or radio waves inside buildings.

The object to be monitored is connected to the data carrier 11. Upon initialization, for example upon turn-on, the data carrier 11 receives the absolute position data from the position -determining system 6 via the position sensor 20. The position data received upon initialization are transmitted directly to the information unit 5. The transmitter 21 provided in the data carrier 11 is used for this purpose. It is also possible to transmit additionally included information, such as time and identification, to the information unit 5. The information unit 5 stores the respective areas in the form of electronic maps. The information unit 5 receives the absolute position data of the location of the object transmitted by the data carrier 11 during the initialization process. In the information unit 5 said absolute position data is assigned to the respective area in which the with the data carrier 11 is now located. The information in which area the object with the data carrier is now located is stored in a data bank of the information unit 5. The boundaries of the area in which the object is located are transmitted back to the data carrier 11. The data carrier 11 receives these boundaries by means of the receiver 22. The boundaries may be transmitted in the form of data of a polygon. The data carrier 11 stores these boundaries in the memory 23.

Depending on the required accuracy the position-determining system 6 is interrogated for the current absolute position by the data carrier 11 at appropriate intervals. Each new position is compared with the boundaries stored in the memory 23 by the comparator 24. There is no communication between the data carrier 11 and the information unit 5 as long as the object with the data carrier 11 is located in the area whose boundaries are stored in the data carrier. The data carrier transmits its absolute position to the information unit 5 only when it is located outside the area and this is has been detected by comparison with the stored boundaries. The information unit then determines the data corresponding to said position data with the aid of the electronic maps stored in it, stores the area which the object has entered, and transmits the new boundaries of the area to the data carrier 11.

This results in an optimization of the communication between the data carrier 11 and the information unit 5 during the time that the data carrier 11 is located within an area. Upon a request to the information unit an application that is interested in the instantaneous position of the data carrier receives the position data of the respective area stored for the relevant data carrier 11. Thus, it is not necessary for the data carrier 11 to be constantly within the receiving range of all possible applications.

An information unit thus serves a multitude of data carriers 11. Different applications can simultaneously access the information unit 5, as a result of which each application need not directly contact the respective data carriers.

Figure 3 shows diagrammatically the time chart for the communication between the elements of the locating system. The process for the data carrier is represented at A, for the information unit at B, for the position-determining system at C, and for an application at D. A step (31) represents the initialization of the data carrier. Subsequently, the data carrier receives its absolute position data from the position-determining system C. The data carrier then transmits this data to the information unit (34). After having received the position data from the data carrier the information unit allocates the absolute position of the data carrier to an area (35) with the aid of the electronic maps stored therein. This area allocation is stored in a data bank of the information unit (36). With the aid of the area thus determined the boundary data for the relevant area is derived. Subsequently, the information unit transmits this boundary data to the data carrier (38). The data carrier receives the area boundary data and stores this data (39). The data carrier receives its current absolute position from the position-determining system. This current absolute position of the data carrier is compared with the boundary data (41). When the object with the data carrier has moved out of the stored area the current absolute position is no longer within the area boundary data. The data carrier then transmits its new absolute position to the information unit (42). In this unit the same steps are performed as after the first transmission of the absolute position (35, 36, 37, 38). If the position is within the area boundary data the new absolute position is not transmitted to the information unit. During this time an application D may have inquired about a data carrier (43). The information unit selects the respective data carrier from the data bank (44) and transmits the instantaneous area where the data carrier is located to the application (45).

There is a wide variety of examples of applications which may be interested in the locations of the individual data carriers. Some of these examples will be outlined briefly. A possible application is a person locating system. All the persons are then given a data carrier and move inside a complex of buildings. When a person is to be traced the information unit can be interrogated, for example via a local computer network. Thus, for example the room or the building where the person is then located is detected.

Another conceivable application is referred to as a "moving map". A position sensor is installed onboard a vehicle. Via this sensor the absolute position of the vehicle is obtained and transmitted to an information unit via a transmission medium. Information

about the locations of individual vehicles can then be obtained from this information unit. Thus, hauling companies can locate vehicles in the entire area respective covered by an information unit.

An extension is the combination of a plurality of information units. The data banks of a plurality of information units are then controlled from a central point, as a result of which the relevant application needs to address only one point.